# B-GRADE MOLASSES

## IN STARTER, GROWER, AND LAYER RATIONS FOR CHICKENS

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The poultry industry is an important segment of the "small farm" agricultural economy of Hawaii, providing a livelihood for more than 400 full and part-time egg and broiler producers, as well as hatcherymen and feed salesmen. Others, such as dock workers, truckers, clerks, drug salesmen, appliance and equipment salesmen, also benefit from the steady source of revenue provided by this industry. In contrast with other areas of poultry production, the poultry industry of Hawaii is almost entirely dependent upon feedstuffs that must be imported across great stretches of water. This dependence upon imported feedstuffs has created a firm impression that the chicken business is a poor risk, because prolonged interruptions in shipping in the past have resulted in the exhaustion of feed reserves, causing distress sales and even total depopulation of flocks. As a consequence, risk capital is seldom available to poultrymen for expansion, and the less venturesome entrepreneur is loath to invest his money to enter this business. The development of indigenous and introduced plants that can be raised in Hawaii to provide economically the nutrients required by chickens is a needed and desirable objective because it would reduce to some extent the precarious dependence of the poultryman on uninterrupted shipping and reduce the risk of his enterprise.

The importation of feed is also a drain on Hawaii's economy. For example, during July 1, 1952, to June 30, 1953, a total of 54,038 tons of poultry feed was sold in the Territory of Hawaii (*1*). If one may assume for purposes of discussion that a ton of feed costs $105, then the flow of dollars from Hawaii for poultry feed alone would equal $5,673,990 during that fiscal year. The development of locally produced feedstuffs could be expected to reduce the amount of money this community is now compelled to spend outside Hawaii for poultry feed. This objective also applies to our other livestock industries.

In order for a locally produced feedstuff to replace an imported one, it must meet the following criteria: it must be produced in adequate amount so as to constitute a dependable supply; it should be priced low enough to be attractive to the buyer; it should, co-ordinated with price, be sufficiently complete in certain nutrients that the farmer will earn at least as much if not more money per dollar invested in this new feedstuff than he has earned previously; and it should not have an unfavorable effect upon the health of the flock or upon the attractiveness of its products. Such a feedstuff would be expected to widen Hawaii's economic base and provide new employment in its production and in the local milling of feed.

Among the many plants that grow in Hawaii, sugar cane is the most valuable. Sugar mills express the juice from cane throughout most of the year; and, during the steps in the processing of raw sugar, B-grade molasses is produced, constituting approximately 7 percent of total cane juice. Because this by-product complies with the criteria stipulated above and is a rich source of carbohydrates, it was biologically assayed to determine the extent to which it may replace yellow corn meal in starter, grower, and layer rations. This bulletin will deal primarily with the economic aspects of the problem. Other portions of these studies have been reported elsewhere (*3*, *4*).

## MATERIALS AND METHODS

In all trials, only New Hampshire chickens produced at the Poultry Farm of the University of Hawaii were fed the experimental rations. The formulas fed to day-old chicks for 6 weeks are shown in tables 1, 2, and 3; those fed to growing cockerels are shown in tables 5 and 6; and those fed to laying birds are shown in tables 7 and 11. An effort was made to provide equivalent gross protein levels in the rations tested in each except the first trial, adjustments in the levels of herring and soybean oil meals being made to replace the proteins lost by the substitution of B-grade molasses and bagasse pith for yellow corn meal. Because of the biological superiority of the amino acids in herring and soybean oil meals as compared with those of corn, it is likely that the B-grade molasses rations were favored somewhat even though the gross protein levels were approximately the same. In general, B-grade molasses and either bagasse pith, wheat bran, or both were used to replace yellow corn meal on a pound for pound basis, the remainder of the rations in each trial, except for the concentrations of herring and soybean oil meals, being held constant.

The B-grade molasses fed in these investigations was produced during the second "strike" of the heated, concentrated cane juices. It was separated from the sugar crystals by centrifugation, the molasses being forcefully hurled through the pores of the centrifuge. The samples of B-grade molasses utilized in these studies had an average composition of 48.3 percent sucrose, 9.4 percent reducing sugars, 11.5 percent organic nonsugars, 10.3 percent ash, and 20.5 percent water (*2*). Because this product is variable in quality, varying in content from season to season and from sample to sample, it is likely that the samples of B-molasses fed during these trials differed somewhat from the average analysis shown above.

Bagasse pith was used in all but trial 7 to serve as a carrier of the B-grade molasses and to help homogenize this molasses into the experimental rations. When the molasses was premixed with the pith in the ratio of 5 parts B-grade molasses to 1 part pith, by weight, and then added to the other ingredients, the resultant mixture was free-flowing and nonviscous. Without special molasses mixing equipment, the addition of B-grade molasses to the other feedstuffs formed a mass of sticky balls of various sizes, thereby resulting in an uneven distribution of the molasses. In trials 1 to 4, the bagasse pith consisted of fine particles of the ground, crushed, and pulped sugar-cane stalk that were separated by liquid screening. The dehydrated, fine particles were later ground in a hammer mill (1/16-inch screen). The fibers were separated on dry screens for trials 5 and 6 and then ground in the same manner.

The estimated cost of each ration fed in this study in no way represented either wholesale or retail prices for feed. These calculations were based on the prices paid by the University of Hawaii. Because the B-grade molasses and bagasse pith were donated by the Experiment Station of the Hawaiian Sugar Planters' Association, an assumed value of $46 per ton was assigned for the molasses and $8.00 per ton for the pith. The prices charged for the other ingredients and supplements used in each study were those current at the time the trial was conducted. No assessments were made for labor, depreciation on investment, etc. The values for poultry and eggs presented in these studies were based on Honolulu wholesale quotations that prevailed at the time each set of data was collected.

## RESULTS

### *Effect of B-grade molasses in chick-starter rations*

#### Trial 1

When the chicks were 3 weeks of age, the duplicate lots fed rations E150, E151, E152, and E153 gained on the average 97.3, 96.4, 93.8, and 79.5 percent, respectively, as much weight as the controls fed ration E149. Upon statistical analysis, the chicks fed ration E152 grew significantly slower than the controls ($P<0.05$) as did those fed ration E153 ($P<0.01$). When the efficiency at which these rations were converted into gain was compared, it was found that rations E150 through E153, respectively, were 3.0, 5.9, 5.9, and 32.2 percent less efficient than control ration E149.

An entirely different conclusion resulted, however, when the cost of feed per pound of gain was considered. As may be seen in table 1, the control ration produced a pound of gain on 12.8 cents of feed; those fed ration E150 required 12.4 cents of feed; and, in turn, rations E151 through E153 required 11.7, 10.6, and 12.0 cents of feed, respectively. Thus, all the molasses rations were more economical than the control ration, if one disregards the factors of gain per unit of time and unit of labor.

At 6 weeks of age, the chicks fed rations E150 through E153 weighed 98.3, 97.7, 91.9, and 77.5 percent as much as the controls. These data were based on straight-run chicks and were, therefore, influenced by the chance distribution of males and females in each group. The average weights of the cockerels and pullets at 6 weeks of age are shown separately in table 4. At that time, the mortality of the chicks, in the order named, was 2.5, 0.0, 2.5, and 5.0 percent. None of the control chicks died in this trial.

### Trial 2

Because no attempt was made to balance the total protein levels of the rations tested in trial 1, this resulted in a pronounced variation in the protein levels of rations E150 through E153. In trial 2, the variation in protein levels that may have resulted from the substitution of B-grade molasses and bagasse pith for yellow corn meal was counterbalanced by compensatory changes in the concentrations of soybean oil meal and herring meal.

As a consequence, the chicks fed rations E145, E146, and E147 gained on the average 92.9, 104.4, and 94.7 percent as much weight, respectively, as the controls fed ration E116 at 3 weeks of age. The variation in growth rate among the lots fed these rations was not statistically significant. However, these rations in the order named were 11.3, 0.5, and 20.8 percent less efficient than the control ration (E116) when the feed consumed by each duplicate set of chicks was divided by their average gain in weight. This, in turn, was offset by the lower cost of the B-grade molasses rations. When the cost of feed per pound of gain in body weight was calculated, it was found that ration E116 required 13.0 cents of feed, whereas rations E145, E146, and E147 required 12.3, 10.6, and 12.2 cents of feed, respectively, to produce a pound of gain. These data are shown in table 2.

No significant difference was found when the body-weight data of the cockerels and pullets at 6 weeks of age were analyzed separately. At that age, the control cockerels averaged 1.82 pounds live weight, whereas the cockerels fed rations E145, E146, and E147 weighed 96.7, 103.3, and 96.2 percent as much. The pullets fed ration E116 (control) averaged 1.53 pounds at 6 weeks of age. In the order named, those fed rations E145, E146, and E147 weighed 93.4, 100.0, and 96.1 percent as much.

As in trial 1, there appeared to be no relationship between the levels of B-grade molasses and bagasse pith fed and mortality. Only 2.5 percent of the chicks died among those fed 40 percent B-grade molasses and 8 percent bagasse pith of total ration.

### Trial 3

A comparison of bagasse pith and wheat bran at four concentrations of B-grade molasses was made in trial 3. This was done because it was thought that the high levels of bagasse pith in rations E152 and E153 may have significantly reduced the total energy values of these rations, thereby reducing growth rate and efficiency of feed conversion. It was also thought that wheat bran might serve as an alternate for pith in homogenizing the molasses into the experimental rations. In general, at each concentration of B-grade molasses, the pith rations were somewhat more friable than the bran rations. The formulations tested in trial 3 are shown in table 3.

After 3 weeks on these rations, the combined lots fed rations E214 through E221 grew 100.0, 103.7, 98.2, 104.6, 93.6, 102.8, 99.1, and 104.6 percent, respectively, as fast as the controls fed ration E213. None of the B-grade molasses-fed lots grew significantly slower than the controls at that age. At each level of sugar, however, those fed wheat bran grew faster than the comparative groups fed higher levels of bagasse pith. When rations E214 and E215, E216 and E217, etc., were compared, those fed the odd-numbered rations (i.e., wheat bran) grew 3.7, 6.5, 9.8, and 5.5 percent faster than their comparative groups.

Certain of the B-grade molasses rations proved to be less costly per unit of gain than the control ration. As may be seen in table 3, rations E214, E215, E219, E220, and E221 produced a pound of gain to 3 weeks of age at less cost than did ration E213.

There was a highly significant difference among the body weights of the male chicks at 6 weeks of age ($P < 0.01$). At that time the controls averaged 1.73 pounds; those fed rations E214, E216, E218, and E220 averaged 1.61, 1.61, 1.69, and 1.60 pounds, respectively; whereas the cockerels fed rations E215, E217, E219, and E221 averaged 1.72, 1.76, 1.76, and 1.74 pounds. Insofar as young cockerels are concerned, these data suggest that they can tolerate as much as 46 percent B-grade molasses of total ration and grow as rapidly as control males to 6 weeks of age. These data also show that bagasse pith adversely affected the growth rate of cockerels when fed in B-grade molasses rations at 4.5 to 9.0 percent of total ration.

No real difference was found, on the other hand, among the body weights of the pullets at 6 weeks of age. The controls averaged 1.44 pounds; those fed rations E214, E216, E218, and E220 averaged 1.46, 1.45, 1.36, and 1.40 pounds, respectively; and the pullets fed rations E215, E217, E219, and E221 averaged 1.42, 1.49, 1.46, and 1.43 pounds. In this comparison, bagasse pith did not adversely affect the growth rate of pullets to 6 weeks of age.

Neither B-grade molasses nor bagasse pith affected livability adversely. Only 2 of 360 experimental chicks died during this 6-week trial.

## *Effect of B-grade molasses in grower rations*

### Trial 4

The rations shown in table 5 were fed to cockerels from 7 to 13 weeks of age. During that interval, the average control fed ration H50 gained 2.7 pounds, whereas the duplicate lots fed rations H51, H52, and H53, respectively, gained 98.3, 100.3, and 88.5 percent as much as the controls. Upon analysis, the variation in body weight among the experimental rations was statistically significant. According to the value of the least significant difference, only the cockerels fed H53 were significantly lighter than the controls. The cockerels fed the control ration (H50) utilized an average of 3.58 pounds of feed to produce a pound of gain. In the order named, those fed rations H51, H52, and H53 required 3.96, 4.43, and 5.34 pounds of feed per pound of gain. As in the chick trials, when the concentrations of B-grade molasses and bagasse pith were raised, efficiency of utilization of these rations was lowered. Only in the case of ration H51 was the difference in price sufficiently large to compensate for the loss in feed efficiency. Whereas 22.7 cents of ration H50 was used to produce a pound of gain, only 22.6 cents of ration H51 was needed. At higher concentrations of B-grade molasses and bagasse pith, the cost of feed per pound of gain exceeded that of the control ration. These values may be seen in table 5.

There were no deaths in trial 4.

### Trial 5

Wheat bran was substituted for part of the bagasse pith in rations H58 and H60 in an effort to determine if bagasse pith was responsible for part of the loss in growth rate and feed efficiency. The changes made in the grower rations fed in trial 5 may be seen in table 6. These rations were fed to 6-week-old cockerels for 6 weeks.

It was found that the controls gained an average of 2.56 pounds in body weight during this 6-week study. In contrast, the cockerels fed rations H57, H58, H59, and H60 gained 2.45, 2.51, 2.04, and 2.22 pounds, respectively. Although none of the B-grade molasses-fed groups gained as much as the controls, those fed ration H58 gained 97.3 percent as much as the controls. When rations H57 and H58, as well as H59 and H60, were compared, it was found that the cockerels fed the even-numbered rations (wheat bran) gained 2.4 and 8.8 percent more weight than the comparative lots, in the order named.

As in trial 4, efficiency of feed utilization decreased as the concentration of B-molasses and bagasse pith was raised. Whereas the controls used 3.31 pounds of feed to produce a pound of gain, those fed rations H57 through H60 required 3.53, 3.51, 4.31, and 4.01 pounds. In the case of rations H57 and H58, the savings resulting from the substitution of 17.75 percent B-grade molasses for corn compensated for the loss in feed efficiency. When the cost of feed per pound of gain was calculated, these rations were somewhat cheaper than the control. Due to the somewhat slower growth rate supported by these rations, however, it is doubtful whether a real saving was made. Rations H59 and H60 proved to be more costly than H56 despite the big difference in price per 100 pounds of feed.

## *Effect of B-grade molasses in layer rations*

### Trial 6

The data shown in table 8 were collected during a period of 20 weeks. When these data were analyzed, it was found that the levels of B-grade molasses fed in this trial significantly affected the characteristics "pounds of feed per dozen ovulations" and "pounds of feed per dozen eggs." According to this analysis, rate of production, incidence of meat and blood spots, soft shell and broken eggs, double yolks, and egg size were not affected adversely by the different concentrations of molasses. On the other hand, the different levels of bagasse pith appeared to be significantly associated only with the incidence of double yolks. This may be a fortuitous observation due to the limited number of layers in each pen and the fact that certain birds typically produced double-yolk eggs. In general, egg production was essentially as good on rations 35 through 40 as on the control ration.

The data shown in table 9 represent the earnings of each pen based on Honolulu wholesale quotations that prevailed at the time of this study. Income was based on unbroken eggs only, and the eggs were graded as they are under commercial conditions. The bottom row of values in table 9 summarizes this study in its most condensed form. Of the rations tested, only rations 38 and 40 were more economical than the control ration. The average income over feed cost per pullet housed of the two groups fed ration 38 was 25 cents greater than that of the controls during this 20-week study, whereas the average income per pullet housed that received ration 40 was 19 cents greater than the controls. Under the conditions that existed when this investigation was conducted, it was profitable to substitute either 20.65 percent of a B-grade molasses-bagasse pith mixture (5:1, by weight) or 20.65 percent B-grade molasses of total ration for yellow corn meal. Greater levels of B-grade molasses, with or without bagasse pith, proved to be uneconomical.

### Trial 7

Each of the rations shown in table 11 was fed to four lots of eight mature pullets arranged in a "Latin Square" design. That is, no ration appeared more than one time in any single row or column of layer pens. As may be seen, these rations contained levels of B-grade molasses that ranged from 0 to 24 percent of total rations. As in trial 6, the experimental rations were fed during an interval that lasted 20 weeks. The data collected from this study are summarized in tables 12 and 13 and in figure 1. Upon analysis, no significant effect of the three levels of B-grade molasses were found on rate of ovulation, rate of egg production, incidence of soft shell and broken eggs, frequency of meat-spot and blood-spot eggs, and increase in egg weight. There was, however, a significant effect of molasses concentrations on body weight gains of the chickens that survived, and on efficiency of feed conversion. The lots fed ration 57 gained significantly less weight than the controls and consumed significantly more feed per dozen ovulations. Those fed ration 58 also gained less weight than the controls ($P > 0.05$) and consumed significantly more feed per dozen ovulations as well as per dozen unbroken eggs. Only the lots fed ration 56 compared favorably with the controls for these two characteristics. In this trial, the average mortalities of the lots fed rations 55 through 58 were 3.12, 9.38, 6.25, and 18.76 percent. The rate of mortality among the lots fed ration 58 proved to be significantly greater than that of the control. These data are summarized in table 14.

A summary of the feed costs and returns from the lots observed in this trial is shown in table 13. As may be seen, the average income over feed cost of the pullets fed rations 55 through 58 during the 20-week interval was \$3.33, \$3.28, \$3.04, and \$3.70, respectively. As the concentrations of B-grade molasses were increased, per-bird-housed income over feed cost decreased by 5, 29, and 63 cents, respectively. In contrast to the results obtained in trial 6, none of the rations containing B-grade molasses were as profitable as the control in this trial.

## DISCUSSION AND CONCLUSIONS

These feeding trials have shown that B-grade molasses may be fed as a substitute for yellow corn meal in starter, grower, and layer rations. Apparently chickens of all ages can safely tolerate this new feedstuff, because even when all the cereal grains were replaced by B-grade molasses no real effect on livability was observed. Thus, as an emergency feedstuff, B-grade molasses can be depended upon to provide the carbohydrate portion of the chicken's ration at all stages of growth. This is a comforting thought in view of the past history of feed shortages in Hawaii that have resulted from emergencies and dock strikes. In the event of restricted shipping, 46.0 percent of a starter ration, 53.6 percent of a grower ration, and 61.75 percent of a layer ration could be provided by B-grade molasses in substitution for the cereal grains with satisfactory results. Under such circumstances, the loss in efficiency of rations containing high concentrations of B-grade molasses would be expected to be offset by compensatory increases in the prices paid for poultry and eggs.

Under the conditions that existed during these investigations, however, it appears that B-grade molasses is not likely to replace all the cereal grains in poultry rations. The results obtained from trials 2 and 3 have shown that the most economical level for chicks fell somewhere between 22.5 and 33.3 percent B-grade molasses of total ration. In trial 2, ration E146, containing 33.3 percent of B-grade molasses, produced 4.4 percent faster growth than the control ration (E116) and at a saving of 2.4 cents in feed per pound of gain. In trial 3, on the other hand, the most efficient ration (E215) contained 23 percent B-grade molasses. This ration supported growth at a rate that was 3.7 percent greater than the controls (E213) and at a saving in feed of 1.0 cent per pound of gain. The results of trial 3 also showed that bagasse pith, excellent carrier of B-grade molasses though it may be, detracted from the nutritive value of the chick's ration. When wheat bran replaced most of the bagasse pith in rations E215, E217, E219, and E221, the growth rates of chicks at comparable levels of B-grade molasses were 3.7, 6.5, 9.8, and 5.5 percent greater than for equivalent rations containing control levels of bagasse pith. For chick rations, at least, these data suggest the desirability of using molasses mixers to combine B-grade molasses directly into the feed mixture, omitting as much bagasse pith as possible from the ration. This is not surprising in view of the chick's limited ability to digest fiber.

The data obtained in trials 4 and 5, in which graded concentrations of B-grade molasses were fed to growing cockerels, are in excellent agreement with the chick trials; namely, that cockerels 6 to 13 weeks of age can also tolerate B-grade molasses to the complete exclusion of the cereal grains, and that efficiency of feed utilization varied inversely to its concentration. In trials 4 and 5, growth rates were obtained on rations H51 and H58 that were 98.3 and 98.0 percent as good as the respective controls. In the case of ration H51, a saving of 0.1 cent in feed was found per pound of gain, whereas ration H58 showed a saving of 0.3 cent. Although the slower rate of growth supported by these rations offset the saving in feed costs, it does appear that B-grade molasses may be fed competitively in Hawaii at these levels. Higher concentrations of B-grade molasses, as determined in trials 4 and 5, were not economically feasible. As in the chick feeding trials, it was also found that bagasse pith detracted from the nutritive value of grower rations. As may be seen in table 6, the growth rates and costs of feed per pound of gain were benefited by the substitution of wheat bran for most of the pith. It would be desirable in the case of grower rations, also, to combine B-molasses directly into the feed mixture by means of a molasses mixer without including bagasse pith.

Laying pullets also tolerated B-grade molasses, and laid fairly well even when all cereal grains were omitted from experimental layer rations 32 and 33. Although the F value obtained "between rations" was not significant, the pullets fed ration 34 laid significantly poorer than the controls. One may conclude from this that bagasse pith had some beneficial effect in the rations containing the higher concentrations of B-grade molasses.

Feed consumption per dozen unbroken eggs increased as the concentration of B-grade molasses was raised. It was found that the controls required 6.45 pounds of feed per dozen eggs. Pullets fed rations in which approximately one third of the cereal grain was replaced by B-grade molasses with or without bagasse pith (rations 38, 39, and 40) used, on the average, 6.34, 6.96, and 6.46 pounds of feed, in the order named. Those fed rations 35, 36, and 37 (approximately two-thirds substitution of the cereal grain) used 7.56, 7.49, and 7.65 pounds of feed, respectively. When all the cereal grain was omitted as in rations 32, 33, and 34, then the average feed consumed per dozen eggs produced was 9.71, 9.14, and 12.76 pounds of feed.

Only in the case of rations 38 and 40 were the experimental rations superior economically to the control. According to the conditions that existed at the time this investigation was conducted, the average income over feed cost per pullet housed was 25 cents greater for ration 38 and 19 cents greater for ration 40 than for the control (ration 31). These data were recorded during an interval of 20 weeks. It is not known how large the differences would be, if any, following an entire year on these rations.

When lower levels of B-grade molasses were fed in trial 7, essentially the same trends were observed. As the concentrations were raised in 8 percent increments to 24 percent of total ration, feed consumption per dozen sound eggs increased. In this trial, however, none of the experimental layer rations were as economical as the control. Following 20 weeks, the average per-bird-housed income over feed cost of the control lots was 5, 29, and 63 cents greater, respectively, than that of the groups fed rations 56, 57, and 58. Statistically, however, there was no real difference among the four rations for rates of ovulation and egg production, incidence of meat- and blood-spot eggs, frequency of soft shell and broken eggs, and average increase in egg size. These data suggest that B-grade molasses could be fed profitably to laying chickens when the price of B-grade molasses is under 2.3 cents per pound and/or when yellow corn meal is sold for more than 5.45 cents per pound.

There should be few obstacles to the practical application of these findings. Because B-grade molasses can be produced readily by plantation mills and transported easily in either tanks or barrels, or incorporated with bagasse pith and bagged, interested persons should be able to contract delivery of this new feedstuff. Poultry farmers could mix the rations shown in this bulletin; commercial feed companies could calculate a balanced ration in which B-grade molasses would replace part of the imported mixture, thereby cutting shipping costs; companies milling these feeds locally could do the same; and new venture capital may be made available to produce proprietary poultry rations with major emphasis on the use of locally produced ingredients. No matter how this procedure is accomplished, it should result in some reduction in the cost of feed to raise replacement stock and broilers and to produce eggs. Then, too, the Territory as a whole should benefit from a reduction in feed importation. If, on the average, 10 percent of present imports were eliminated through the use of B-grade molasses, this would represent a saving to Hawaii of approximately $567,399 per annum.

## SUMMARY

1. Seven feeding trials were conducted with chicks, growing cockerels, and laying pullets to determine the comparative value of B-grade molasses in chicken rations. In these studies B-grade molasses was substituted for yellow corn meal, and, in all but the first trial, adjustments in the levels of herring and soybean oil meals were made to replace the proteins lost by these substitutions.

2. It was found that chickens in the three age groups safely tolerated this new feedstuff even when all the cereal grains were replaced by B-grade molasses. Thus, as an emergency feedstuff, B-grade molasses can be depended upon to provide the carbohydrate portion of the chicken's ration during all stages of growth. In the event of restricted shipping, 46.0 percent of a starter ration, 53.6 percent of a grower ration, and 61.75 percent of a layer ration could be provided by B-grade molasses with satisfactory results.

3. Efficiency of feed utilization decreased as the concentration of B-grade molasses was raised. As a consequence, comparatively high levels of B-grade molasses proved

to be uneconomical when compared with comparable starter, grower, and layer control rations.

4. Under the conditions that existed during these studies, the most economical concentration of B-grade molasses in chick starter rations ranged between 22.5 and 33.3 percent of total ration. At these levels growth rates were faster and the costs of feed per pound of gain was less than those of the controls. In the trials with cockerels from 6 to 13 weeks of age, rations containing 17.75 and 18.2 percent B-grade molasses of total ration supported growth equal to 98.0 and 98.3 percent of the controls, and at a saving of 0.3 and 0.1 cent of feed per pound of gain, respectively.
Higher concentrations of B-grade molasses were uneconomical despite the lower cost of feed.

5. The data showed that bagasse pith adversely affected the growth of chicks and growing cockerels when fed at concentrations ranging from 4.5 to 9.0 percent of total ration. The substitution of wheat bran for equivalent amounts of bagasse pith resulted in an increased rate of growth.

6. The data obtained with laying pullets in two trials have shown that levels of B-grade molasses ranging to 24 percent of total ration do not adversely affect the rates of ovulation and egg production, incidence of meat- and blood-spot eggs, frequency of soft shell and broken eggs, and increase in egg size. However, feed consumption increased significantly as the concentration of B-grade molasses was raised. In trial 6, experimental layer rations containing 17.15 and 20.65 percent B-grade molasses produced eggs more economically than the control. In trial 7, none of the B-grade molasses rations were as economical as the control. With reference to laying chickens, these data suggested that B-grade molasses could be fed profitably when it is priced below 2.3 cents per pound and/or when yellow corn meal is priced above 5.45 cents per pound.

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Table 1. Composition of starter rations tested and results obtained in trial 1.

| INGREDIENTS* | EXPERIMENTAL RATIONS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | E149 | | E150 | | E151 | | E152 | | E153 | |
| B-grade molasses | 0.0 | | 11.25 | | 22.5 | | 33.75 | | 45.0 | |
| Bagasse pith | 0.0 | | 2.25 | | 4.5 | | 6.75 | | 9.0 | |
| Ground yellow corn | 54.0 | | 40.50 | | 27.0 | | 13.50 | | 0.0 | |
| Herring meal | 10.0 | | Remainder of experimental rations E150 through E153 as shown for E149 | | | | | | | |
| Soybean oil meal | 30.0 | | | | | | | | | |
| Alfalfa meal | 3.0 | | | | | | | | | |
| Ground oyster shell | 0.5 | | | | | | | | | |
| Defluorinated phosphate† | 2.0 | | | | | | | | | |
| Salt | 0.5 | | | | | | | | | |
| Manganese sulfate, gm. | 11.0 | | | | | | | | | |
| Aurofac, gm.§ | 200.0 | | | | | | | | | |
| Choline chloride, gm.** | 200.0 | | | | | | | | | |
| Delsterol, gm.‡ | 30.0 | | | | | | | | | |
| Niacin, mg. | 900.0 | | | | | | | | | |
| Pantothenic acid, mg. | 500.0 | | | | | | | | | |
| Riboflavin, mg. | 160.0 | | | | | | | | | |
| Thiamine hydrochloride, mg. | 50.0 | | | | | | | | | |
| Calculated protein, percent | 25.7 | | 24.4 | | 23.2 | | 22.0 | | 20.8 | |
| Estimated cost per cwt., dollars | 6.39 | | 5.92 | | 5.45 | | 4.99 | | 4.52 | |
| Average gain to 3 weeks of age, lb. | 0.55 | 0.57 | 0.55 | 0.54 | 0.53 | 0.55 | 0.51 | 0.54 | 0.44 | 0.45 |
| Average feed consumed, lb. | 1.26 | 0.99 | 1.24 | 1.04 | 1.11 | 1.21 | 1.10 | 1.14 | 1.11 | 1.27 |
| Pounds of feed per pound of gain | 2.29 | 1.74 | 2.25 | 1.92 | 2.09 | 2.20 | 2.16 | 2.11 | 2.52 | 2.82 |
| Cost of feed per pound of gain, cents | 14.6 | 11.1 | 13.3 | 11.4 | 11.4 | 12.0 | 10.8 | 10.5 | 11.4 | 12.7 |
| Average of duplicate lots, cents | 12.8 | | 12.4 | | 11.7 | | 10.6 | | 12.0 | |

* Unless otherwise specified, the unit of measure is pound(s).
† Defluorophos (International Mineral and Chemical Corp.)=31.5 percent calcium and 13.1 percent phosphorus.
§ Aurofac (Lederle)=guaranteed minimum potency of not less than 1.8 mg. $B_{12}$ activity and 1.8 gm. aureomycin per pound.
** Feedgrade choline chloride (Lederle)=217 mgs. choline per gram.
‡ Delsterol (Du Pont)=2000 A.O.A.C. units of D per gram.

Table 2. Composition of starter rations tested and results obtained in trial 2.

| INGREDIENTS* | EXPERIMENTAL STARTER RATIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | E116 | | E145 | | E146 | | E147 | |
| B-grade molasses | 0.0 | | 26.7 | | 33.3 | | 40.0 | |
| Bagasse pith | 0.0 | | 5.3 | | 6.7 | | 8.0 | |
| Ground yellow corn | 56.5 | | 24.5 | | 16.5 | | 8.5 | |
| Soybean oil meal | 37.5 | | 33.5 | | 30.0 | | 28.0 | |
| Herring meal | 0.0 | | 4.0 | | 7.5 | | 9.5 | |
| Alfalfa meal | 3.0 | | Remainder of rations E145 through E147 as shown for ration E116 | | | | | |
| Ground oyster shell | 0.5 | | | | | | | |
| Defluorinated phosphate | 2.0 | | | | | | | |
| Salt | 0.5 | | | | | | | |
| Manganese sulfate, gm. | 11.0 | | | | | | | |
| Aurofac, gm | 200.0 | | | | | | | |
| Choline chloride, gm. | 200.0 | | | | | | | |
| Delsterol, gm. | 30.0 | | | | | | | |
| Niacin, mg. | 900.0 | | | | | | | |
| Pantothenic acid, mg. | 500.0 | | | | | | | |
| Riboflavin, mg. | 160.0 | | | | | | | |
| Calculated protein, percent | 22.2 | | 20.3 | | 20.5 | | 20.2 | |
| Estimated cost per cwt., dollars | 6.58 | | 5.51 | | 5.32 | | 5.08 | |
| Average gain to 3 weeks of age, lb. | 0.56 | 0.57 | 0.52 | 0.53 | 0.60 | 0.58 | 0.56 | 0.51 |
| Average feed consumed, lb. | 1.19 | 1.04 | 1.10 | 1.24 | 1.10 | 1.24 | 1.20 | 1.34 |
| Pounds of feed per pound of gain | 2.12 | 1.82 | 2.12 | 2.34 | 1.83 | 2.14 | 2.14 | 2.63 |
| Cost of feed per pound of gain, cents | 13.9 | 12.0 | 11.7 | 12.9 | 9.7 | 11.4 | 10.9 | 13.4 |
| Average of duplicate lots, cents | 13.0 | | 12.3 | | 10.6 | | 12.2 | |

* Refer to table 1 for additional information concerning ingredients.

Table 3. Composition of starter rations tested and results obtained in trial 3.

| INGREDIENTS* | EXPERIMENTAL STARTER RATIONS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E213 | | E214 | | E215 | | E216 | | E217 | | E218 | | E219 | | E220 | | E221 | |
| B-grade molasses | 0.0 | | 23.0 | | 23.0 | | 29.5 | | 29.5 | | 37.0 | | 37.0 | | 46.0 | | 46.0 | |
| Bagasse pith | 0.0 | | 4.5 | | 0.5 | | 6.0 | | 0.5 | | 7.5 | | 1.0 | | 9.0 | | 1.0 | |
| Wheat bran | 0.0 | | 0.0 | | 4.0 | | 0.0 | | 5.5 | | 0.0 | | 6.5 | | 0.0 | | 8.0 | |
| Ground yellow corn | 65.0 | | 32.5 | | 32.5 | | 22.5 | | 22.5 | | 12.5 | | 12.5 | | 0.0 | | 0.0 | |
| Soybean oil meal | 21.0 | | 24.0 | | 24.0 | | 25.0 | | 25.0 | | 25.0 | | 25.0 | | 26.0 | | 26.0 | |
| Herring meal | 7.0 | | 9.0 | | 9.0 | | 10.0 | | 10.0 | | 11.0 | | 11.0 | | 12.0 | | 12.0 | |
| Alfalfa meal | 3.0 | | Remainder of rations E214 through E221 as shown for ration E213 | | | | | | | | | | | | | | | |
| Ground oyster shell | 0.5 | | | | | | | | | | | | | | | | | |
| Defluorinated phosphate | 2.0 | | | | | | | | | | | | | | | | | |
| Salt | 0.5 | | | | | | | | | | | | | | | | | |
| Manganese sulfate, gm. | 11.0 | | | | | | | | | | | | | | | | | |
| Aurofac, gm. | 200.0 | | | | | | | | | | | | | | | | | |
| Choline chloride, gm. | 200.0 | | | | | | | | | | | | | | | | | |
| Delsterol, gm. | 30.0 | | | | | | | | | | | | | | | | | |
| Niacin, mg. | 900.0 | | | | | | | | | | | | | | | | | |
| Pantothenic acid, mg. | 160.0 | | | | | | | | | | | | | | | | | |
| Riboflavin, mg. | 50.0 | | | | | | | | | | | | | | | | | |
| Calculated protein, percent | 20.5 | | 20.3 | | 20.9 | | 20.5 | | 21.4 | | 20.3 | | 21.4 | | 20.3 | | 21.6 | |
| Estimated cost per cwt., dollars | 6.56 | | 5.66 | | 5.90 | | 5.42 | | 5.74 | | 5.12 | | 5.50 | | 4.79 | | 5.26 | |
| Average gain to 3 weeks of age, lb. | 0.55 | 0.54 | 0.54 | 0.55 | 0.56 | 0.57 | 0.51 | 0.56 | 0.55 | 0.59 | 0.50 | 0.52 | 0.55 | 0.57 | 0.54 | 0.54 | 0.55 | 0.59 |
| Average feed consumed, lb. | 1.11 | 1.02 | 1.10 | 1.30 | 1.16 | 1.09 | 1.15 | 1.45 | 1.40 | 1.39 | 1.28 | 1.68 | 1.28 | 1.28 | 1.35 | 1.39 | 1.35 | 1.39 |
| Pounds of feed per pound of gain | 2.02 | 1.89 | 2.04 | 2.36 | 2.07 | 1.91 | 2.25 | 2.59 | 2.54 | 2.36 | 2.56 | 3.23 | 2.33 | 2.24 | 2.50 | 2.57 | 2.45 | 2.36 |
| Cost of feed per pound of gain, cents | 13.2 | 12.4 | 11.5 | 13.4 | 12.2 | 11.3 | 12.2 | 14.0 | 14.6 | 13.5 | 13.1 | 16.5 | 12.8 | 12.3 | 12.0 | 12.3 | 12.9 | 12.4 |
| Average of duplicate lots, cents | 12.8 | | 12.4 | | 11.8 | | 13.1 | | 14.0 | | 14.8 | | 12.6 | | 12.2 | | 12.6 | |

* Refer to table 1 for additional information concerning ingredients.

Table 4. Comparison of body weights (in pounds) of chicks fed experimental B-grade molasses-type starter rations to 6 weeks of age.

| | AVERAGE BODY WEIGHTS AT 6 WEEKS OF AGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Trial 1** | | | | | | | | | |
| Rations | E149 | E150 | E151 | E152 | E153 | | | | |
| Replicate 1, male | 1.75 | 1.69 | 1.68 | 1.56 | 1.31 | | | | |
| Replicate 2, male | 1.69 | 1.62 | 1.77 | 1.65 | 1.42 | | | | |
| Replicate 1, female | 1.46 | 1.48 | 1.37 | 1.34 | 1.13 | | | | |
| Replicate 2, female | 1.48 | 1.48 | 1.49 | 1.35 | 1.14 | | | | |
| Average | | | | | | | | | |
| Male | 1.72 | 1.66 | 1.72 | 1.60 | 1.36 | | | | |
| Female | 1.47 | 1.48 | 1.43 | 1.34 | 1.13 | | | | |
| **Trial 2** | | | | | | | | | |
| Rations | E116 | E145 | E146 | E147 | | | | | |
| Replicate 1, male | 1.87 | 1.77 | 1.87 | 1.83 | | | | | |
| Replicate 2, male | 1.76 | 1.76 | 1.88 | 1.67 | | | | | |
| Replicate 1, female | 1.52 | 1.43 | 1.59 | 1.49 | | | | | |
| Replicate 2, female | 1.54 | 1.43 | 1.47 | 1.46 | | | | | |
| Average | | | | | | | | | |
| Male | 1.82 | 1.76 | 1.88 | 1.75 | | | | | |
| Female | 1.53 | 1.43 | 1.53 | 1.47 | | | | | |
| **Trial 3** | | | | | | | | | |
| Rations | E213 | E214 | E215 | E216 | E217 | E218 | E219 | E220 | E221 |
| Replicate 1, male | 1.70 | 1.58 | 1.71 | 1.55 | 1.76 | 1.70 | 1.73 | 1.66 | 1.71 |
| Replicate 2, male | 1.77 | 1.63 | 1.73 | 1.67 | 1.76 | 1.68 | 1.78 | 1.52 | 1.76 |
| Replicate 1, female | 1.44 | 1.42 | 1.36 | 1.49 | 1.43 | 1.34 | 1.45 | 1.37 | 1.43 |
| Replicate 2, female | 1.44 | 1.50 | 1.48 | 1.41 | 1.53 | 1.38 | 1.47 | 1.43 | 1.44 |
| Average | | | | | | | | | |
| Male | 1.73 | 1.61 | 1.72 | 1.61 | 1.76 | 1.69 | 1.76 | 1.60 | 1.74 |
| Female | 1.44 | 1.46 | 1.42 | 1.45 | 1.49 | 1.36 | 1.46 | 1.40 | 1.43 |

Table 5. Composition of grower rations tested and results obtained in trial 4.

| INGREDIENTS* | EXPERIMENTAL GROWER RATIONS H50 | | H51 | | H52 | | H53 | |
|---|---|---|---|---|---|---|---|---|
| B-grade molasses | 0.0 | | 18.2 | | 36.0 | | 53.6 | |
| Bagasse pith | 0.0 | | 1.8 | | 3.5 | | 5.4 | |
| Yellow corn meal | 70.5 | | 47.0 | | 23.5 | | 0.0 | |
| Soybean oil meal | 20.0 | | 21.5 | | 23.5 | | 25.5 | |
| Herring meal | 3.0 | | 5.0 | | 7.0 | | 9.0 | |
| Alfalfa meal | 4.0 | | Remainder of experimental grower rations H51 through H53 as shown for H50 | | | | | |
| Defluorinated phosphate | 1.5 | | | | | | | |
| Salt | 0.5 | | | | | | | |
| Ground oyster shell | 0.4 | | | | | | | |
| Manganese sulfate, gm. | 10.0 | | | | | | | |
| Aurofac, gm. | 50.0 | | | | | | | |
| Feedgrade choline chloride, gm. | 70.0 | | | | | | | |
| Delsterol, gm. | 12.0 | | | | | | | |
| Niacin, mg. | 300.0 | | | | | | | |
| Pantothenic acid, mg. | 160.0 | | | | | | | |
| Pyridoxine hydrochloride, mg. | 160.0 | | | | | | | |
| Thiamine hydrochloride, mg. | 70.0 | | | | | | | |
| Calculated protein, percent | 18.10 | | 17.97 | | 18.06 | | 18.16 | |
| Estimated cost per cwt., dollars | 6.35 | | 5.72 | | 5.15 | | 4.56 | |
| | A | B | A | B | A | B | A | B |
| Average gain from 7 to 13 weeks of age, lbs. | 2.72 | 2.67 | 2.64 | 2.66 | 2.74 | 2.66 | 2.45 | 2.32 |
| Average feed consumed, lbs. | 9.79 | 9.49 | 10.45 | 10.39 | 11.84 | 12.07 | 13.18 | 12.30 |
| Pounds of feed per pound of gain | 3.60 | 3.55 | 4.00 | 3.91 | 4.32 | 4.54 | 5.38 | 5.30 |
| Cost of feed per pound gain, cents | 22.9 | 22.5 | 22.9 | 22.4 | 22.2 | 23.4 | 24.5 | 24.2 |
| Average of duplicate lots, cents | 22.70 | | 22.65 | | 22.80 | | 24.35 | |

* Refer to table 1 for additional information concerning ingredients.

Table 6. Composition of grower rations tested and results obtained in trial 5.

| INGREDIENTS* | EXPERIMENTAL GROWER RATIONS * | | | | |
|---|---|---|---|---|---|
| | H56 | H57 | H58 | H59 | H60 |
| B-grade molasses | 0.0 | 17.75 | 17.75 | 36.0 | 36.0 |
| Wheat bran | 0.0 | 0.00 | 2.00 | 0.0 | 4.0 |
| Bagasse pith | 0.0 | 1.75 | 0.50 | 3.5 | 0.5 |
| Yellow corn meal | 75.5 | 53.00 | 53.00 | 30.0 | 30.0 |
| Soybean oil meal | 9.0 | 9.00 | 9.00 | 9.0 | 9.0 |
| Herring meal | 9.0 | 12.00 | 11.25 | 15.0 | 14.0 |
| Alfalfa meal | 4.0 | Remainder of experimental grower rations H57 through H60 as shown for H56 | | | |
| Defluorinated phosphate | 1.5 | | | | |
| Salt | 0.5 | | | | |
| Ground oyster shell | 0.4 | | | | |
| Manganese sulfate, gm. | 10.0 | | | | |
| Feedgrade choline chloride, gm. | 70.0 | | | | |
| Delsterol, gm. | 12.0 | | | | |
| Niacin, mg. | 300.0 | | | | |
| Pantothenic acid, mg. | 160.0 | | | | |
| Pyridoxine hydrochloride, mg. | 160.0 | | | | |
| Thiamine hydrochloride, mg. | 70.0 | | | | |
| Calculated protein, percent | 17.91 | 17.92 | 17.72 | 17.88 | 17.84 |
| Estimated cost per cwt., dollars | 6.26 | 5.84 | 5.85 | 5.40 | 5.47 |

| | H56 A | H56 B | H57 A | H57 B | H58 A | H58 B | H59 A | H59 B | H60 A | H60 B |
|---|---|---|---|---|---|---|---|---|---|---|
| Average gain from 6 to 12 weeks of age, lbs. | 2.54 | 2.58 | 2.50 | 2.40 | 2.49 | 2.53 | 2.01 | 2.07 | 2.17 | 2.28 |
| Average feed consumed, lbs. | 8.45 | 8.49 | 8.85 | 8.46 | 8.73 | 8.83 | 8.71 | 8.89 | 9.02 | 8.87 |
| Pounds of feed per pound of gain | 3.33 | 3.29 | 3.54 | 3.52 | 3.51 | 3.49 | 4.33 | 4.29 | 4.16 | 3.89 |
| Cost of feed per pound gain, cents | 20.8 | 20.6 | 20.7 | 20.6 | 20.5 | 20.4 | 23.4 | 23.2 | 22.8 | 21.3 |
| Average of duplicate lots, cents | 20.70 | | 20.65 | | 20.45 | | 23.30 | | 22.05 | |

* Refer to table 1 for additional information concerning ingredients.

Table 7. Experimental layer rations tested in trial 6.

| INGREDIENTS* | EXPERIMENTAL LAYER RATIONS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| B-grade molasses | 0.00 | 51.50 | 56.75 | 61.25 | 34.35 | 37.80 | 41.25 | 17.15 | 18.90 | 20.65 |
| Bagasse pith | 0.00 | 10.25 | 5.00 | 0.00 | 6.90 | 3.45 | 0.00 | 3.50 | 1.75 | 0.00 |
| Yellow corn meal | 75.00 | 0.00 | 0.00 | 0.00 | 25.00 | 25.00 | 25.00 | 50.00 | 50.00 | 50.00 |
| Herring meal | 4.00 | 7.50 | 7.50 | 7.50 | 6.25 | 6.25 | 6.25 | 5.10 | 5.10 | 5.10 |
| Soybean oil meal | 14.25 | 24.00 | 24.00 | 24.00 | 20.75 | 20.75 | 20.75 | 17.50 | 17.50 | 17.50 |
| Alfalfa meal | 3.0 | Remainder of experimental rations 32 through 40 as shown for ration 31 | | | | | | | | |
| Defluorinated phosphate | 3.0 | | | | | | | | | |
| Salt | 0.5 | | | | | | | | | |
| Manganese sulfate, gm. | 6.0 | | | | | | | | | |
| Ferrous sulfate, mg. | 100.0 | | | | | | | | | |
| Copper sulfate, mg. | 100.0 | | | | | | | | | |
| Choline chloride, gm. | 100.0 | | | | | | | | | |
| Delsterol, gm. | 30.0 | | | | | | | | | |
| Niacin, mg. | 400.0 | | | | | | | | | |
| Riboflavin, mg. | 50.0 | | | | | | | | | |
| Thiamine, mg. | 60.0 | | | | | | | | | |
| Calculated cost per cwt., dollars† | 5.70 | 3.74 | 3.84 | 3.92 | 4.39 | 4.46 | 4.52 | 5.04 | 5.08 | 5.11 |

* Refer to table 1 for additional information concerning ingredients.
† B-grade molasses calculated at $46 per ton and bagasse pith at $8.00 per ton.

Table 8. Summary of data obtained in trial 6 during an interval of 20 weeks.

| CHARACTERISTIC | EXPERIMENTAL LAYER RATIONS | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 31 | | 32 | | 33 | | 34 | | 35 | | 36 | | 37 | | 38 | | 39 | | 40 | |
| | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| Percentage hen-day ovulations* | 69.40 | 66.40 | 57.60 | 58.00 | 56.40 | 70.20 | 54.60 | 37.10 | 66.20 | 69.00 | 66.00 | 66.30 | 65.90 | 68.00 | 74.50 | 71.00 | 64.20 | 59.40 | 69.10 | 70.60 |
| Percentage hen-day production† | 59.40 | 48.70 | 45.80 | 51.20 | 49.20 | 56.60 | 39.90 | 31.90 | 51.00 | 60.40 | 53.90 | 56.50 | 57.90 | 52.60 | 60.40 | 59.50 | 51.60 | 56.10 | 59.20 | 59.10 |
| Percentage meat and blood spots detected by candling† | 9.00 | 11.20 | 9.70 | 6.60 | 10.30 | 8.70 | 6.40 | 11.70 | 9.80 | 9.80 | 10.50 | 9.00 | 10.10 | 13.80 | 13.70 | 10.50 | 11.40 | 8.90 | 10.00 | 11.70 |
| Percentage soft shells and broken eggs§ | 14.30 | 26.70 | 20.70 | 11.70 | 12.80 | 19.20 | 27.00 | 14.10 | 23.10 | 13.20 | 18.50 | 13.80 | 12.40 | 22.80 | 19.50 | 16.10 | 19.60 | 5.30 | 14.40 | 15.90 |
| Percentage double-yolk eggs | 0.10 | 0.90 | 1.60 | 0.80 | 0.90 | 0.50 | 2.00 | 1.50 | 1.50 | 0.30 | 0.30 | 0.40 | 1.70 | 2.60 | 0.10 | 0.40 | 0.70 | 0.40 | 1.00 | 0.70 |
| Average increase in egg weight, gm | 5.70 | 5.30 | 7.10 | 5.30 | 4.60 | 4.90 | 8.10 | 4.40 | 4.70 | 4.90 | 5.00 | 7.40 | 5.80 | 6.50 | 5.70 | 6.90 | 6.50 | 5.70 | 6.20 | 6.70 |
| Average increase in body weight of survivors, pound(s) | 1.24 | 0.95 | 0.10 | 0.08 | 0.40 | 0.26 | 0.66 | 0.28 | 0.15 | 0.39 | 0.38 | 0.79 | 0.70 | 0.60 | 0.43 | 0.36 | 0.78 | 0.59 | 0.52 | 0.59 |
| Pounds of feed per dozen ovulations | 4.94 | 5.24 | 8.78 | 7.39 | 8.44 | 6.94 | 8.74 | 11.65 | 6.21 | 6.17 | 6.16 | 6.34 | 6.10 | 6.46 | 4.99 | 5.47 | 5.94 | 6.17 | 5.38 | 5.56 |
| Pounds of feed per dozen eggs† | 5.76 | 7.15 | 11.03 | 8.38 | 9.67 | 8.61 | 11.95 | 13.57 | 8.06 | 7.06 | 7.54 | 7.44 | 6.95 | 8.35 | 6.15 | 6.52 | 7.39 | 6.53 | 6.28 | 6.63 |
| Percentage mortality | 0.00 | 20.00 | 0.00 | 10.00 | 0.00 | 20.00 | 0.00 | 10.00 | 40.00 | 0.00 | 10.00 | 10.00 | 0.00 | 10.00 | 0.00 | 10.00 | 10.00 | 0.00 | 0.00 | 0.00 |

* These values include soft shell and broken eggs detected by daily inspection under laying pens and by candling.
† Soft shell and broken eggs excluded from these calculations.
§ These values are based on total detected ovulations.

Table 9. Summary of income (in dollars) from duplicate lots in trial 6.

| CHARACTERISTIC | EXPERIMENTAL LAYER RATIONS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| Value of eggs*† | 111.45 | 92.42 | 103.20 | 65.33 | 103.97 | 107.30 | 112.00 | 120.38 | 106.48 | 119.74 |
| Pounds of feed consumed | 797.5 | 1,062.4 | 1,059.5 | 1,010.0 | 880.5 | 918.5 | 972.8 | 867.2 | 864.2 | 891.2 |
| Value of feed consumed | 45.46 | 39.73 | 40.68 | 39.59 | 38.65 | 40.97 | 43.97 | 43.71 | 43.90 | 45.54 |
| Return of eggs over feed cost | 65.99 | 52.69 | 62.52 | 25.74 | 65.32 | 66.33 | 68.03 | 76.67 | 62.58 | 74.20 |
| Return over feed cost per bird housed | 3.30 | 2.63 | 3.13 | 1.29 | 3.27 | 3.32 | 3.40 | 3.83 | 3.13 | 3.71 |
| Average increase in body weight, lb(s) | 1.11 | 0.09 | 0.34 | 0.48 | 0.30 | 0.59 | 0.65 | 0.40 | 0.68 | 0.56 |
| Value of average increase in body weight | 0.44 | 0.04 | 0.14 | 0.19 | 0.12 | 0.24 | 0.26 | 0.16 | 0.27 | 0.22 |
| Total return over feed cost per bird housed | 3.74 | 2.67 | 3.27 | 1.48 | 3.39 | 3.56 | 3.66 | 3.99 | 3.40 | 3.93 |
| Difference in per-bird-housed income from control | 0.00 | −1.07 | −0.47 | −2.26 | −0.35 | −0.18 | −0.08 | +0.25 | −0.34 | +0.19 |

* Whereas all soft shell and broken eggs were not included in these calculations, eggs containing small meat and blood spots were included.
† Average of duplicate lots fed the experimental rations shown in table 7.

Table 10. Statistical analyses of data obtained in trial 6.

| CHARACTERISTIC | BETWEEN SUGAR LEVELS | | | BETWEEN LEVELS OF BAGASSE | | |
|---|---|---|---|---|---|---|
| | F value | Significant | Degrees of freedom | F value | Significant | Degrees of freedom |
| Percentage hen-day ovulations | 3.005 | No | 2 and 4 | 0.387 | No | 2 and 4 |
| Percentage hen-day production | 3.210 | No | 2 and 4 | 0.455 | No | 2 and 4 |
| Percentage meat and blood spots detected by candling | 1.862 | No | 2 and 12 | 0.007 | No | 2 and 2 |
| Percentage soft shells and broken eggs | 0.397 | No | 2 and 12 | 0.549 | No | 2 and 12 |
| Percentage double-yolk eggs | 3.401 | No | 2 and 12 | 8.423** | Yes | 2 and 12 |
| Average increase in egg weight, gm | 0.440 | No | 2 and 12 | 0.447 | No | 2 and 12 |
| Pounds of feed per dozen ovulations | 15.427** | Yes | 2 and 12 | 1.090 | No | 2 and 12 |
| Pounds of feed per dozen eggs | 16.870** | Yes | 2 and 12 | 1.581 | No | 2 and 12 |

** $P<0.01$ percent due to chance alone.

Table 11. Experimental layer rations tested in trial 7.

| INGREDIENTS* | EXPERIMENTAL LAYER RATIONS | | | |
|---|---|---|---|---|
| | 55 | 56 | 57 | 58 |
| B-grade molasses | 0.0 | 8.0 | 16.0 | 24.0 |
| Napier meal | 3.0 | 4.0 | 5.0 | 6.0 |
| Yellow corn meal | 75.0 | 64.6 | 54.2 | 43.9 |
| Herring meal | 4.0 | 4.1 | 4.2 | 4.3 |
| Soybean oil meal | 14.2 | 15.5 | 16.8 | 18.0 |
| Defluorinated phosphate | 3.0 | | | |
| Salt | 0.5 | | | |
| Manganese sulfate, gm. | 6.0 | Remainder of experimental layer rations 56 through 58 as shown for ration 55 | | |
| Feedgrade choline chloride, gm. | 100.0 | | | |
| Delsterol, gm. | 30.0 | | | |
| Niacin, mg. | 400.0 | | | |
| Riboflavin, mg. | 50.0 | | | |
| Thiamine hydrochloride, mg. | 60.0 | | | |
| Calculated protein, percent | 16.52 | 16.57 | 16.63 | 16.65 |
| Calculated cost per cwt., dollars | 5.81 | 5.55 | 5.39 | 5.04 |

* Refer to tables 1 and 7 for additional information concerning this table.

Table 12. Data obtained in trial 7.

| CHARACTERISTIC | RATIONS 55 Pens 1 | 8 | 11 | 14 | 56 Pens 2 | 5 | 12 | 15 | 57 Pens 3 | 6 | 9 | 16 | 58 Pens 4 | 7 | 10 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage hen-day ovulations* | 74.6 | 72.5 | 70.6 | 66.0 | 71.9 | 73.3 | 59.6 | 69.2 | 66.9 | 66.6 | 73.0 | 66.9 | 62.4 | 62.7 | 69.8 | 63.3 |
| Percentage hen-day production† | 57.1 | 60.8 | 58.0 | 50.7 | 58.6 | 64.6 | 50.4 | 55.4 | 56.6 | 55.6 | 60.9 | 51.4 | 50.7 | 47.8 | 59.7 | 47.1 |
| Percentage meat and blood spots detected by candling† | 11.1 | 9.3 | 10.3 | 6.8 | 8.7 | 6.0 | 8.7 | 10.7 | 7.3 | 11.6 | 7.2 | 5.9 | 7.5 | 8.2 | 10.5 | 8.6 |
| Percentage soft shell and broken eggs§ | 23.4 | 16.1 | 17.9 | 23.1 | 18.5 | 11.9 | 15.2 | 19.9 | 15.4 | 16.4 | 16.6 | 23.2 | 18.7 | 23.9 | 14.5 | 25.6 |
| Percentage double-yolk eggs | 0.5 | 0.1 | 0.1 | 0.0 | 0.3 | 0.0 | 0.1 | 0.4 | 0.7 | 0.5 | 0.5 | 0.3 | 0.3 | 0.6 | 0.0 | 0.3 |
| Average increase in egg weight, gm. | 8.1 | 5.1 | 7.1 | 7.3 | 6.8 | 5.2 | 5.7 | 7.1 | 6.7 | 7.6 | 5.2 | 7.6 | 7.0 | 8.9 | 6.5 | 7.6 |
| Average increase in body weight of survivors, pound(s) | 1.02 | 0.80 | 0.95 | 0.82 | 0.76 | 1.02 | 1.01 | 1.11 | 0.55 | 0.67 | 0.78 | 0.46 | 0.53 | 0.71 | 1.02 | 0.90 |
| Pounds of feed per dozen ovulations | 5.1 | 4.7 | 5.0 | 4.9 | 5.0 | 5.2 | 5.3 | 5.2 | 5.7 | 6.0 | 5.1 | 5.6 | 5.9 | 6.1 | 5.7 | 6.1 |
| Pounds of feed per dozen eggs† | 6.7 | 5.6 | 6.1 | 6.4 | 6.1 | 5.9 | 6.3 | 6.6 | 6.7 | 7.2 | 6.1 | 7.3 | 7.3 | 8.0 | 6.7 | 8.2 |
| Percentage mortality | 0.0 | 0.0 | 12.5 | 0.0 | 12.5 | 0.0 | 0.0 | 25.0 | 0.0 | 12.5 | 0.0 | 12.5 | 12.5 | 37.5 | 12.5 | 12.5 |

* These values include soft shell and broken eggs detected by daily inspection under laying pens and by candling.
† Soft shell and broken eggs excluded from these calculations.
§ These values are based on total detected ovulations.

Table 13. Summary of income (in dollars) from quadruplicate lots fed experimental layer rations for 20 weeks.

| CHARACTERISTIC | EXPERIMENTAL LAYER RATIONS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 55 | | | | 56 | | | | 57 | | | | 58 | | | |
| | Pens | | | | Pens | | | | Pens | | | | Pens | | | |
| | 1 | 8 | 11 | 14 | 2 | 5 | 12 | 15 | 3 | 6 | 9 | 16 | 4 | 7 | 10 | 13 |
| Value of eggs*................ | 43.53 | 43.94 | 42.28 | 39.12 | 40.75 | 43.84 | 36.94 | 41.22 | 42.94 | 41.32 | 43.63 | 37.09 | 36.60 | 33.89 | 40.01 | 34.68 |
| Pounds of feed consumed....... | 357.00 | 315.60 | 315.50 | 301.80 | 295.80 | 356.50 | 295.00 | 321.20 | 354.20 | 365.00 | 347.80 | 343.50 | 339.80 | 313.80 | 350.00 | 349.50 |
| Value of feed consumed......... | 20.74 | 18.34 | 18.33 | 17.53 | 16.42 | 19.78 | 16.37 | 17.83 | 19.09 | 19.67 | 18.75 | 18.51 | 17.12 | 15.82 | 17.64 | 17.61 |
| Return of eggs over feed cost.... | 22.79 | 25.60 | 23.95 | 21.59 | 24.33 | 24.06 | 20.57 | 23.39 | 23.85 | 21.65 | 24.88 | 18.58 | 19.48 | 18.07 | 22.37 | 17.07 |
| Value of added body weight..... | 3.67 | 2.88 | 2.99 | 2.95 | 2.39 | 3.67 | 3.64 | 3.00 | 1.98 | 2.11 | 2.81 | 1.45 | 1.67 | 1.60 | 3.21 | 2.83 |
| Total return over feed cost....... | 26.46 | 28.48 | 26.94 | 24.54 | 26.72 | 27.73 | 24.21 | 26.39 | 25.83 | 23.76 | 27.69 | 20.03 | 21.15 | 19.67 | 25.58 | 19.90 |
| Total return over feed cost per bird housed................. | 3.31 | 3.56 | 3.37 | 3.07 | 3.34 | 3.47 | 3.03 | 3.30 | 3.23 | 2.97 | 3.46 | 2.50 | 2.64 | 2.46 | 3.20 | 2.49 |
| Average return over feed cost for four lots................. | 3.33 | | | | 3.28 | | | | 3.04 | | | | 2.70 | | | |
| Difference in per-bird-housed income from control (ration 55) | 0.00 | | | | −0.05 | | | | −0.29 | | | | −0.63 | | | |

* Whereas all soft shell and broken eggs were not included in these calculations, eggs containing small meat and blood spots were included.

Table 14. Statistical analyses of data obtained in trial 7.

| CHARACTERISTIC | F VALUE | SIGNIFICANT | DEGREES OF FREEDOM |
| --- | --- | --- | --- |
| Hen-day ovulations | 1.231 | No | 3 and 6 |
| Hen-day production | 1.049 | No | 3 and 6 |
| Frequency of meat- and blood-spot eggs | 0.220 | No | 3 and 6 |
| Frequency of soft shell and broken eggs | 1.210 | No | 3 and 6 |
| Increase in egg weight | 0.897 | No | 3 and 6 |
| Increase in body weight of survivors | 6.446* | Yes | 3 and 6 |
| Pounds of feed per dozen ovulations | 9.963* | Yes | 3 and 6 |
| Pounds of feed per dozen sound eggs | 5.664* | Yes | 3 and 6 |
| Percentage mortality | 2.333 | No | 3 and 6 |

* $P<0.05$ percent due to chance alone.

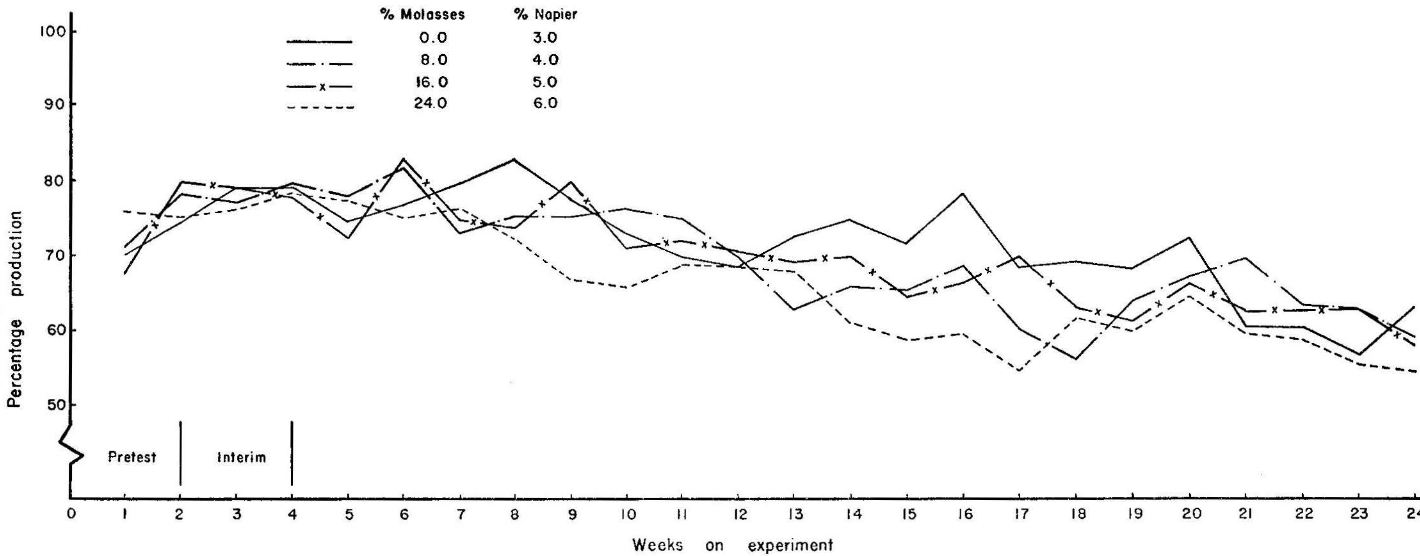


Fig. 1. Percentage production of New Hampshire pullets during trial 7.

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